Amendment To The Claims

Below is a listing of the claims that will replace all prior versions and listings of claims in the present patent application.

1. (Currently Amended) A method for formulating a bi-directional color match, comprising:

obtaining a plurality of spectral measurements of a target bi-directional color; and

determining a combination of pigments, dyes and platelet-shaped pigments having a plurality of predicted spectral measurements that match the plurality of spectral measurements of the target bi-directional color, wherein the determining comprises obtaining a plurality of optical parameters for each of the pigments, dyes and platelet-shaped pigments and applying the plurality of optical parameters to a single particle scattering algorithm.

2. (Canceled)

3. (Canceled)

4. (Currently Amended) The method according to claim 1 [[3]], wherein the single particle scattering algorithm uses Mie scattering and a Monte Carlo method based on geometric optics ray-tracing.

5. (Currently Amended) The method according to claim 1 [[3]], further comprising applying output from the single particle scattering algorithm to a multiple scattering algorithm.

6. (Original) The method according to claim 5, wherein the multiple scattering algorithm uses an Adding and Doubling matrix method and a Fourier series expansion technique.

7. (Original) The method according to claim 5, further comprising applying output from the multiple scattering algorithm to a non-linear squares fitting method to determine a formula comprising a combination of pigments, dyes and platelet-shaped pigments and concentrations thereof that match the target bi-directional color.

8. (Currently Amended) A method for formulating a bi-directional color match from a set of previously used bi-directional color formulations, comprising:

obtaining a plurality of spectral measurements of a target bi-directional color;

searching the set of previously used bi-directional color formulations for color formulas that approximates the target bi-directional color;

determining from the color formulas a formula that best matches the target bi-directional color;

applying optical parameters associated with the pigments, dyes and platelet-shaped pigments in the color formula having the best match to a single particle scattering algorithm;

determining the concentrations of the pigments, dyes and platelet-shaped pigments in the color formula in accordance with the single particle scattering algorithm, wherein the determined concentrations generate a predicted visible spectra that matches the spectral measurements associated with the target bi-directional color; and

adapting the concentrations of the pigments, dyes and platelet-shaped pigments in the color formula if necessary.

9. (Original) The method according to claim 8, further comprising examining color plaques made from the adapted color formula and determining the acceptability of the formula.

10. (Original) The method according to claim 8, further comprising modifying the adapted color formula if the formula is unacceptable, the modifying comprising at least one of manual adjusting the concentrations of the pigments, dyes and platelet-shaped pigments in the formula, synthesizing a match with the target bi-directional color, or searching through the set of previously used bi-directional color formulations to find an acceptable match.

11. (Original) The method according to claim 8, further comprising receiving matching requirements for obtaining the set of color formulas that approximates the target bi-directional color, wherein the matching requirements comprise a plurality of optical parameters.

12. (Original) The method according to claim 8, further comprising storing the color formula having the acceptable match with the set of previously used bi-directional color formulations.

13. (Currently Amended) A method for formulating a bi-directional color match from a set of previously used bi-directional color formulations, comprising:

obtaining a plurality of spectral measurements of a target bi-directional color;

receiving matching requirements for obtaining color formulas that approximates the target bi-directional color;

searching the set of previously used bi-directional color formulations according to the matching requirements;

determining from the set of color formulas a color formula that best matches the target bi-directional color according to the matching requirements;

applying optical parameters associated with the pigments, dyes and platelet-shaped pigments in the color formula having the best match to a single particle scattering algorithm;

determining the concentrations of the pigments, dyes and platelet-shaped pigments in the color formula in accordance with the single particle scattering algorithm, wherein the determined concentrations generate a predicted visible spectra that matches the spectral measurements associated with the target bi-directional color;

adapting the concentrations of the pigments, dyes and platelet-shaped pigments in the color formula; and

determining if the adapted color formula matches the target bi-directional color.

14. (Original) The method according to claim 13, further comprising examining color plaques made from the adapted color formula and determining the acceptability of the formula.

15. (Original) The method according to claim 13, further comprising modifying the adapted color formula if the formula is unacceptable, the modifying comprising at least one of manual adjusting the concentrations of the pigments, dyes and platelet-shaped pigments in the color formula, synthesizing a match with the target bi-directional color, or searching through the set of previously used bi-directional color formulations until there is an acceptable match.

16. (Original) The method according to claim 13, further comprising storing the color formula having the acceptable match with the set of previously used bi-directional color formulations.

17. (Currently Amended) A method for formulating a bi-directional color match from a set of previously used bi-directional color formulations, comprising:

obtaining a plurality of spectral measurements of a target bi-directional color;

receiving ~~entering~~ matching requirements for obtaining color formulas that approximates the target bi-directional color;

searching the set of previously used bi-directional color formulations according to the matching requirements;

determining from the set of color formulas a color formula that best matches the target bi-directional color according to the matching requirements;

applying optical parameters associated with the pigments, dyes and platelet-shaped pigments in the color formula having the best match to a single particle scattering algorithm;

determining the concentrations of the pigments, dyes and platelet-shaped pigments in the color formula in accordance with the single particle scattering algorithm, wherein the determined concentrations generate a predicted visible spectra that matches the spectral measurements associated with the target bi-directional color;

adapting the concentrations of the pigments, dyes and platelet-shaped pigments in the color formula to improve the match with the target bi-directional color if the formula is unacceptable;

determining if the adapted color formula matches the target bi-directional color; and

modifying the adapted color formula if the formula is unacceptable, the modifying comprising at least one of manual adjusting the concentrations of the pigments, dyes and platelet-shaped pigments in the color formula, synthesizing a match with the target bi-directional color, or searching through the set of previously used bi-directional color formulations until there is an acceptable match.

18. (Currently Amended) A system for formulating a bi-directional color match, comprising:

a spectrophotometer that obtains a plurality of spectral measurements of a target bi-directional color;

a color database containing a plurality of optical parameters associated with pigments, dyes and platelet-shaped pigments used in previously used bi-directional color formulations; and

a computing unit that determines a combination of pigments, dyes and metal flake ~~fake~~ pigments having a plurality of predicted spectral measurements that match the plurality of spectral measurements of the target bi-directional color, wherein the computing unit obtains the plurality of optical parameters from the color database for each of the pigments, dyes and platelet-shaped pigments in the combination that matches the target bi-directional color and applies the plurality optical parameters to a single particle scattering algorithm.

19. (Canceled)

20. (Canceled)

21. (Canceled)

22. (Currently Amended) The system according to claim 18 [[21]], wherein the single particle scattering algorithm uses Mie scattering and a Monte Carlo method based on geometric optics ray-tracing.

23. (Currently Amended) The system according to claim 18 [[21]], wherein the computing unit applies output from the single particle scattering algorithm to a multiple scattering algorithm.

24. (Original) The system according to claim 23, wherein the multiple scattering algorithm uses an Adding and Doubling matrix method and a Fourier series expansion technique.

25. (Original) The system according to claim 23, wherein the computing unit applies output from the multiple scattering algorithm to a non-linear squares fitting method to determine a formula comprising a combination of pigments, dyes and platelet-shaped pigments and concentrations thereof that match the target bi-directional color.

26. (Currently Amended) A system for formulating a bi-directional color match from a set of previously used bi-directional color formulations, comprising:

a spectrophotometer that obtains a plurality of spectral measurements of a target bi-directional color;

a color database containing a plurality of previously used bi-directional color formulations and a plurality of optical parameters associated with each of the pigments, dyes and platelet-shaped pigments used in the bi-directional color formulations; and

a computing unit, coupled to the spectrophotometer and color database, that searches the color ~~databasefor~~ database for a set of color formulas that approximates the target bi-directional color and determines from the set of color formulas a color formula that best matches the target bi-directional color measured by the spectrophotometer, wherein the computing unit obtains the plurality of optical parameters from the color database for each of the pigments, dyes and platelet-shaped pigments in the combination that matches the target bi-directional color and applies the plurality optical parameters to a single particle scattering algorithm and applies output from the single particle scattering algorithm to a multiple scattering algorithm.

27. (Original) The system according to claim 26, wherein the computing unit adapts the concentrations of the pigments, dyes and platelet-shaped pigments in the color formula.

28. (Original) The system according to claim 27, wherein the computing unit determines if the adapted color formula matches the target bi-directional color.

29. (Original) The system according to claim 28, wherein the computing unit modifies the adapted color formula if the formula is unacceptable, the modifying including at least one of manual adjusting the concentrations of the pigments, dyes and platelet-shaped pigments in the formula, synthesizing a match with the target bi-directional color, or searching through the color database of previously used bi-directional color formulations until there is an acceptable match.

30. (Original) The system according to claim 29, wherein the computing unit stores the color formula having the acceptable match in the color database.

31. (Currently Amended) A bi-directional color formulation tool, comprising:

a data acquisition component that obtains a plurality of spectral measurement of a target bi-directional color from a spectrophotometer;

a data extraction component that extracts a set of previously used color formulations that approximates the target bi-directional color data from a color database and determines a formula from the set that best matches the target bi-directional color; and

a bi-directional color matching component that determines the concentrations of the pigments, dyes and platelet-shaped pigments in the formula to generate a predicted visible spectra that matches the target bi-directional color spectra, wherein the bi-directional color matching component determines from the set of color formulas a formula that best matches the target bi-directional color and applies a plurality of optical parameters associated with the pigments, dyes and platelet-shaped pigments in the color formula having the best match to a single particle scattering algorithm.

32. (Original) The tool according to claim 31, further comprising a color modifying component that modifies the formula if it is unacceptable, the color modifying component performing at least one of manual adjusting the concentrations of the pigments, dyes and platelet-shaped pigments in the color formula, synthesizing a match with the target bi-directional color, or searching through the set of previously used bi-directional color formulations until there is an acceptable match.

33. (Currently Amended) A computer-readable medium storing computer instructions for instructing a computer system to formulate a bi-directional color match, the computer instructions comprising:

obtaining a plurality of spectral measurements of a target bi-directional color; and

determining a combination of pigments, dyes and platelet-shaped pigments having a plurality of predicted spectral measurements that match the plurality of spectral measurements of the target bi-directional color, wherein the determining comprises instructions for obtaining a plurality of optical parameters for each of the pigments, dyes and platelet-shaped pigments and applying the plurality of optical parameters to a single particle scattering algorithm.

34. (Canceled)

35. (Canceled)

36. (Currently Amended) The computer-readable medium according to claim 33 [[35]], wherein the single particle scattering algorithm uses Mie scattering and a Monte Carlo method based on geometric optics ray-tracing.

37. (Currently Amended) The computer-readable medium according to claim 33 [[35]], further comprising instructions for applying output from the single particle scattering algorithm to a multiple scattering algorithm.

38. (Original) The computer-readable medium according to claim 37, wherein the multiple scattering algorithm uses an Adding and Doubling matrix method and a Fourier series expansion technique.

39. (Original) The computer-readable medium according to claim 37, further comprising instructions for applying output from the multiple scattering algorithm to a non-linear squares fitting method to determine a formula comprising a combination of pigments, dyes and platelet-shaped pigments and concentrations thereof that match the target bi-directional color.

40. (Currently Amended) A computer-readable medium storing computer instructions for instructing a computer system to formulate a bi-directional color match from a set of previously used bi-directional color formulations, the computer instructions comprising:

obtaining a plurality of spectral measurements of a target bi-directional color;

searching the set of previously used bi-directional color formulations for color formulas that approximates the target bi-directional color;

determining from the color formulas a formula that best matches the target bi-directional color;

applying optical parameters associated with the pigments, dyes and platelet-shaped pigments in the color formula having the best match to a single particle scattering algorithm;

determining the concentrations of the pigments, dyes and platelet-shaped pigments in the color formula in accordance with the single particle scattering algorithm, wherein the determined concentrations generate a predicted visible spectra that matches the spectral measurements associated with the target bi-directional color; and

adapting the concentrations of the pigments, dyes and platelet-shaped pigments in the color formula if desired.

41. (Original) The computer-readable medium according to claim 40, further comprising instructions for modifying the adapted color formula if the formula is unacceptable, the modifying comprising at least one of manual adjusting the concentrations of the pigments, dyes and platelet-shaped pigments in the formula, synthesizing a match with the target bi-directional color, or searching through the set of previously used bi-directional color formulations to find an acceptable match.

42. (Original) The computer-readable medium according to claim 40, further comprising instructions for receiving matching requirements for obtaining the set of color formulas that approximates the target bi-directional color.

43. (Original) The computer-readable medium according to claim 40, further comprising instructions for storing the color formula having the acceptable match with the set of previously used bi-directional color formulations.

44. (Currently Amended) A computer-readable medium storing computer instructions for instructing a computer system to formulate a bi-directional color match from a set of previously used bi-directional color formulations, the computer instructions comprising:

obtaining a plurality of spectral measurements of a target bi-directional color;

receiving matching requirements for obtaining color formulas that approximates the target bi-directional color;

searching the set of previously used bi-directional color formulations according to the matching requirements;

determining from the set of color formulas a color formula that best matches the target bi-directional color according to the matching requirements;

applying optical parameters associated with the pigments, dyes and platelet-shaped pigments in the color formula having the best match to a single particle scattering algorithm;

determining the concentrations of the pigments, dyes and platelet-shaped pigments in the color formula in accordance with the single particle scattering algorithm, wherein the determined concentrations generate a predicted visible spectra that matches the spectral measurements associated with the target bi-directional color;

adapting the concentrations of the pigments, dyes and platelet-shaped pigments in the color formula; and

determining if the adapted color formula matches the target bi-directional color.

45. (Original) The computer-readable medium according to claim 44, further comprising instructions for modifying the adapted color formula if the formula is unacceptable, the modifying comprising at least one of manual adjusting the concentrations of the pigments, dyes and platelet-shaped pigments in the color formula, synthesizing a match with the target bi-directional color, or searching through the set of previously used bi-directional color formulations until there is an acceptable match.

46. (Original) The computer-readable medium according to claim 44, further comprising instructions for storing the color formula having the acceptable match with the set of previously used bi-directional color formulations.

47. (Currently Amended) A computer-readable medium storing computer instructions for instructing a computer system to formulate a bi-directional color match from a set of previously used bi-directional color formulations, the computer instructions comprising:

obtaining a plurality of spectral measurements of a target bi-directional color;

receiving ~~entering~~ matching requirements for obtaining color formulas that approximates the target bi-directional color;

searching the set of previously used bi-directional color formulations according to the matching requirements;

determining from the set of color formulas a color formula that best matches the target bi-directional color according to the matching requirements;

applying optical parameters associated with the pigments, dyes and platelet-shaped pigments in the color formula having the best match to a single particle scattering algorithm;

determining the concentrations of the pigments, dyes and platelet-shaped pigments in the color formula in accordance with the single particle scattering algorithm, wherein the determined concentrations generate a predicted visible spectra that matches the spectral measurements associated with the target bi-directional color;

adapting the concentrations of the pigments, dyes and platelet-shaped pigments in the color formula to improve the match with the target bi-directional color if the formula is unacceptable;

determining if the adapted color formula matches the target bi-directional color; and

modifying the adapted color formula if the formula is unacceptable, the modifying comprising at least one of manual adjusting the concentrations of the pigments, dyes and platelet-shaped pigments in the color formula, synthesizing a match with the target bi-directional color, or searching through the set of previously used bi-directional color formulations until there is an acceptable match.

48. (New) The method according to claim 8, wherein the single particle scattering algorithm uses Mie scattering and a Monte Carlo method based on geometric optics ray-tracing.

49. (New) The method according to claim 8, further comprising applying output from the single particle scattering algorithm to a multiple scattering algorithm.

50. (New) The method according to claim 49, wherein the multiple scattering algorithm uses an Adding and Doubling matrix method and a Fourier series expansion technique.

51. (New) The method according to claim 49, further comprising applying output from the multiple scattering algorithm to a non-linear squares fitting method.

52. (New) The method according to claim 13, wherein the single particle scattering algorithm uses Mie scattering and a Monte Carlo method based on geometric optics ray-tracing.

53. (New) The method according to claim 13, further comprising applying output from the single particle scattering algorithm to a multiple scattering algorithm.

54. (New) The method according to claim 53, wherein the multiple scattering algorithm uses an Adding and Doubling matrix method and a Fourier series expansion technique.

55. (New) The method according to claim 53, further comprising applying output from the multiple scattering algorithm to a non-linear squares fitting method.

56. (New) The method according to claim 17, wherein the single particle scattering algorithm uses Mie scattering and a Monte Carlo method based on geometric optics ray-tracing.

57. (New) The method according to claim 17, further comprising applying output from the single particle scattering algorithm to a multiple scattering algorithm.

58. (New) The method according to claim 57, wherein the multiple scattering algorithm uses an Adding and Doubling matrix method and a Fourier series expansion technique.

59. (New) The method according to claim 57, further comprising applying output from the multiple scattering algorithm to a non-linear squares fitting method.

60. (New) The system according to claim 26, wherein the single particle scattering algorithm uses Mie scattering and a Monte Carlo method based on geometric optics ray-tracing.

61. (New) The system according to claim 26, wherein the multiple scattering algorithm uses an Adding and Doubling matrix method and a Fourier series expansion technique.

62. (New) The system according to claim 26, wherein the computing unit applies output from the multiple scattering algorithm to a non-linear squares fitting method.

63. (New) The tool according to claim 31, wherein the single particle scattering algorithm uses Mie scattering and a Monte Carlo method based on geometric optics ray-tracing.

64. (New) The tool according to claim 31, wherein the bi-directional color matching component applies output from the single particle scattering algorithm to a multiple scattering algorithm.

65. (New) The tool according to claim 64, wherein the multiple scattering algorithm uses an Adding and Doubling matrix method and a Fourier series expansion technique.

66. (New) The tool according to claim 64, wherein the bi-directional color matching component applies output from the multiple scattering algorithm to a non-linear squares fitting method.

67. (New) The computer-readable medium according to claim 40, wherein the single particle scattering algorithm uses Mie scattering and a Monte Carlo method based on geometric optics ray-tracing.

68. (New) The computer-readable medium according to claim 40, further comprising instructions for applying output from the single particle scattering algorithm to a multiple scattering algorithm.

69. (New) The computer-readable medium according to claim 68, wherein the multiple scattering algorithm uses an Adding and Doubling matrix method and a Fourier series expansion technique.

70. (New) The computer-readable medium according to claim 68, further comprising instructions for applying output from the multiple scattering algorithm to a non-linear squares fitting method.

71. (New) The computer-readable medium according to claim 44, wherein the single particle scattering algorithm uses Mie scattering and a Monte Carlo method based on geometric optics ray-tracing.

72. (New) The computer-readable medium according to claim 44, further comprising instructions for applying output from the single particle scattering algorithm to a multiple scattering algorithm.

73. (New) The computer-readable medium according to claim 72, wherein the multiple scattering algorithm uses an Adding and Doubling matrix method and a Fourier series expansion technique.

74. (New) The computer-readable medium according to claim 72, further comprising instructions for applying output from the multiple scattering algorithm to a non-linear squares fitting method.

75. (New) The computer-readable medium according to claim 47, wherein the single particle scattering algorithm uses Mie scattering and a Monte Carlo method based on geometric optics ray-tracing.

76. (New) The computer-readable medium according to claim 47, further comprising instructions for applying output from the single particle scattering algorithm to a multiple scattering algorithm.

77. (New) The computer-readable medium according to claim 76, wherein the multiple scattering algorithm uses an Adding and Doubling matrix method and a Fourier series expansion technique.

78. (New) The computer-readable medium according to claim 76, further comprising instructions for applying output from the multiple scattering algorithm to a non-linear squares fitting method.